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Reducing Complexity by Creating Complexity: A Systems Theory Perspective on How Organizations Respond to Their Environments

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ABSTRACT Organizations have to cope with the complexity of their environment in order to survive. A considerable body of research has shown that organizations may respond to environmental complexity by creating *internal complexity* – for example, by expanding internal structures and processes. However, researchers know less about how organizations create *collaborative complexity* collectively – for example, by establishing alliances or developing common standards. This paper uses social systems theory to explore how organizations collaborate in response to complexity and to analyse the conditions under which they create either internal or collaborative complexity (or both) to address environmental complexity. It also examines how these types of complexity feed back into environmental complexity. To illustrate our conceptual model, we use corporate social responsibility (CSR).

Keywords: collaborative complexity, corporate social responsibility (CSR), environmental complexity, internal complexity, interorganizational collaboration, social systems theory

INTRODUCTION

The question of how organizations respond to environmental complexity, commonly defined as 'the number of items or elements that must be dealt with simultaneously by an organization' (Scott, 1992, p. 230), has been central to organizational research from early on (Burns and Stalker, 1966; Emery and Trist, 1965; Lawrence and Lorsch, 1967) and has surfaced repeatedly in many works (Chandler, 2014; Child and Rodrigues, 2011; Faulconbridge and Muzio, 2015; Reus et al., 2009). The common assumption that organizations respond to increased environmental complexity by modifying their structures, processes, rules, or routines (Daft and Lengel, 1986; Galbraith, 1982; Galunic and Eisenhardt, 1994) stems from early research in cybernetics (Ashby, 1956).

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Since then, many scholars have extensively examined how organizations cope with environmental complexity at the level of individual organizations (Ghoshal and Nohria, 1989; Pache and Santos, 2010; Scott and Meyer, 1987; Siggelkow and Rivkin, 2005; Weick, 1976). Many of these works analyse organizational responses to environmental complexity from the perspective of mathematical complexity theory, building on concepts such as chaos, non-linearity, and unpredictability (Anderson, 1999; Boisot and Child, 1999; Maguire et al., 2006; Tsoukas, 1998).

In contrast, much less is known about how organizations interact in order to respond to environmental complexity (Aldrich, 1979; Borch and Arthur, 1995; Wood and Gray, 1991). While collaboration among organizations is a widely observed phenomenon (Ahuja, 2000; Dyer and Singh, 1998; Gulati et al., 2012; Hardy et al., 2003; Huxham and Vangen, 2005), little is known about how collaboration may help organizations cope with environmental complexity. In view of this gap, our research objective in this paper is to explore the phenomenon of collaboration between organizations and to investigate the conditions in which organizations address environmental complexity either on their own or in collaboration with other organizations. Examining collaboration as a possible response to environmental complexity is of great theoretical and practical relevance because collaboration is becoming increasingly important among organizations – particularly among business firms – in complex and pluralistic environments.

To develop our ideas, we draw on social systems theory, which offers a complexity-based sociological perspective on how social systems respond to challenges in their environment. This theory postulates that a system (such as a business firm) is necessarily less complex than its environment (Luhmann, 1995) because, to operate efficiently, a system selects only a limited amount of all the information that is available outside its boundaries. The resulting *complexity differential* between a system and its environment is the defining element of all social systems.

The existence of a complexity differential implies that a social system cannot simultaneously take into account all the elements of its environment (such as emerging issues that suddenly become relevant to the system) and how these elements interconnect (Luhmann, 1995; Seidl and Becker, 2006). If the complexity differential becomes too large, however, a social system may no longer have sufficient information or the knowledge to process available information in order to make informed decisions (Daft and Lengel, 1986). As a result, in such a situation a system can no longer respond even to crucial environmental demands that can threaten its viability. Consequently, in order to survive when the complexity differential increases, a system needs to increase its own complexity relative to that of its environment and thus reduce the differential again to a manageable level.

Drawing on social systems theory, we develop a conceptual model that explains why firms respond to environmental complexity by creating either internal or collaborative complexity. In this paper, 'internal complexity' refers to an organization's internal structures and processes. Increasing internal complexity may be accomplished by means of functional specialisation, structural differentiation, or by enhancing organizational processes. 'Collaborative complexity', in contrast, refers to the joint creation of structures and processes by at least two organizations so that they can collectively respond to factors that they simultaneously regard as an increase in the complexity of their

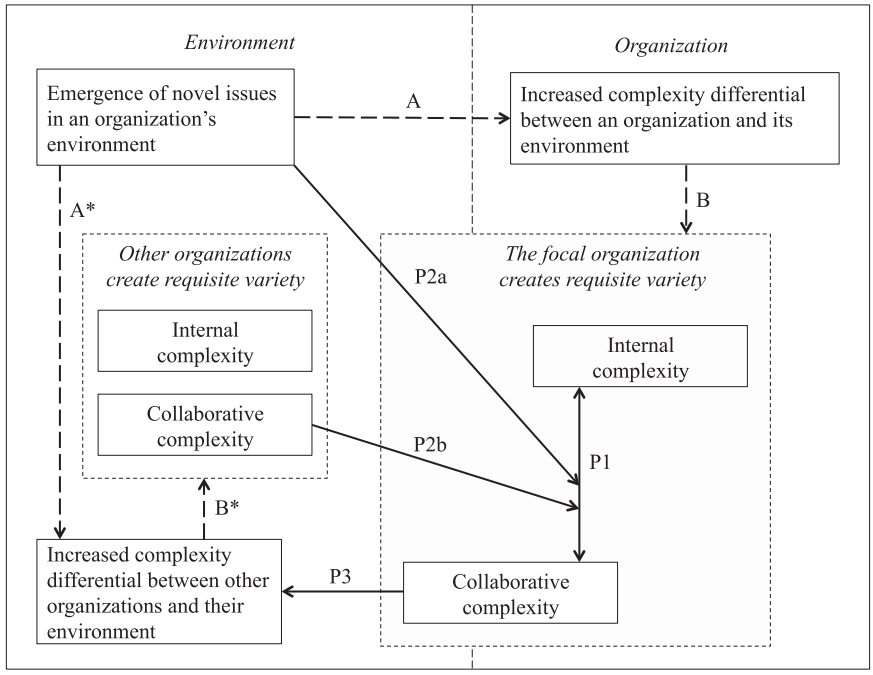

Figure 1. Organizational responses to environmental complexity

respective (and potentially overlapping) environments. In the rest of the paper, when we refer to organizational 'environment', we assume that every organization perceives its own distinct environment, whose elements may also be part of the environment of other organizations. To create collaborative complexity, organizations may, for instance, form strategic alliances or set up initiatives to create new industry norms and standards.

Our model builds on a central tenet of social systems theory, according to which organizations reduce their complexity differential by increasing their internal complexity. Expanding on this tenet, we show that an organization can also reduce its complexity differential by creating collaborative complexity and explain why organizations in some circumstances tackle environmental complexity on their own (by creating internal complexity), while in other circumstances they do so in collaboration with other organizations (by creating collaborative complexity). We also explain why reducing the complexity differential of one organization can, at the same time, increase the environmental complexity that other organizations perceive. The latter's responses to this increase in their own environmental complexity influence in turn the focal organization's effort to reduce its complexity differential by means of different combinations of internal and collaborative complexity. Figure 1 introduces our conceptual model and the main thrust of our argument.

Our paper contributes to research on organizational responses to complexity in three ways. First, it contributes to the literature on interorganizational collaboration. Applying a systems theory lens, we develop the concept of collaborative complexity to show how organizations collectively react to environmental complexity. Second, our study contributes to discussions on organizational complexity by offering a parsimonious explanation

of why organizations combine internal and collaborative complexity in different ways. Third, we extend the scope of social systems theory by connecting the organizational level with the field level and explaining the endogenous dynamics of field-level change.

The paper is structured as follows: in the next section we explain the basic tenets of social systems theory. In the main section, we develop our conceptual model (Figure 1) and introduce our propositions. We then apply the model to the context of corporate social responsibility (CSR) in order to illustrate its theoretical relevance. We conclude our paper with a discussion on the contributions of our study and its implications for future research.

SOCIAL SYSTEMS THEORY AND COMPLEXITY

Social systems theory has its roots in cybernetics, a field of research that seeks to identify the general laws that govern biological, physical, and social systems (Ashby, 1956; von Bertalanffy, 1950; Wiener, 1965). Parsons (1951) and subsequently Luhmann (1973, 1975, 1995, 2013) comprehensively applied the ideas of cybernetics to the analysis of social systems and developed them further. Drawing on those ideas, Luhmann went on to formulate an extensive and differentiated theory of social systems (Borch, 2011). His theory provides a highly idiosyncratic and complex conceptual apparatus that can be used to analyse diverse areas of social life, such as whole societies, societal subsystems (such as the economic or political system), organizations, and face-to-face interactions (Langenmayr, 2016; Seidl and Schoeneborn, 2016). Luhmann's ideas are increasingly harnessed in organization theory (for an overview, see Seidl and Mormann, 2014) – for example, in the debate on rigour and relevance (Kieser and Leiner, 2009; Nicolai, 2004; Nicolai and Seidl, 2010) or in the 'communication as constitutive of organizations' (CCO) perspective (Brummans et al., 2014; Cooren et al., 2011; Schoeneborn, 2011). In order to analyse usefully and accessibly how organizations react to environmental complexity, we restrict our analysis to some of the most basic concepts of the theory of social systems: complexity, social systems, complexity differential, and requisite variety.

The concepts of 'complexity' and 'social systems' are closely related. In social systems theory, complexity refers to the number of elements that constitute a system or the environment of a system, and to the connections between these elements. The greater the number of elements and their interrelations, the higher the degree of complexity (Luhmann, 1975). According to systems theory, social systems (societies, organizations, and interactions) are always less complex than their environments. Furthermore, systems are not capable of grasping at once all the relationships between the elements that make up their environments. Systems theorists distinguish between different types of systems (Baraldi et al., 1997; Luhmann, 1995). Of these types, the most relevant systems in our context are organizations such as business firms, governmental organizations, and non-governmental organizations (NGOs). In this paper, we therefore use the terms 'system' and 'organization' interchangeably.

As already explained, the concept of the complexity differential describes the difference between the complexity of a system and the complexity of its environment. Importantly, in contrast to absolute definitions of complexity, social systems theory

conceptualizes the degree of environmental complexity as entirely dependent on the observing system. In this respect, 'the environment is a system-relative situation' (Luhmann, 1995, p. 181). Each system observes and ascribes a certain degree of complexity to its environment. According to Luhmann (1975), a system of high complexity perceives its environment as relatively less complex. When the complexity of a system is low, however, that system perceives its environment as highly complex, because the complexity differential is high.

The above indicates that, according to social systems theory, the degree of complexity that a system ascribes to its environment depends on its own complexity. Social systems select aspects of their environment that they regard as relevant to their survival and ignore aspects that they regard as irrelevant (Schreyögg and Steinmann, 1987). Through this process of selection social systems construct a specific environment, concentrate on specific tasks, and thus maintain their operational efficiency (Luhmann, 1997). However, if the perceived complexity differential between a social system and its environment becomes too large (i.e., if the system's own complexity remains too low relative to that of the environment), the system's resulting inability to grasp the complexity of its environment (Duncan, 1972) jeopardizes its survival. Because the organizational environment is subject to constant change (Emery and Trist, 1965) – for instance, with regard to economic, technological, physical, and political conditions (Child and Rodrigues, 2011) – organizations are constantly challenged to discover new elements that might become relevant to their survival and constantly need to adjust their own complexity in order to remain viable.

The idea that by increasing its own complexity a system increases the range of actions it can take to tackle environmental complexity is expressed in the concept of *requisite variety*, which was introduced by Ashby (1956) and later picked up by Luhmann (1995). This fairly broad concept implies that systems need to be able to form a representation of environmental complexity in order to address it, and, to do so, they need to possess a certain degree of complexity (see also Galunic and Eisenhardt, 1994). Specifically, this means that the larger the variety of actions available to a system, the greater the extent of environmental complexity it is able to handle. The basic assumptions are simple: a system can only control something to the extent that it possesses sufficient requisite variety to form a representation of that thing. For example, in order to choose between two alternatives, a system must be able to describe – and thereby represent – at least these two options. The scope of requisite variety that a system possesses delimits the range of variety that it can control.

The above overview suggests that, in order to respond to the challenges of increased environmental complexity, a system needs to possess a sufficient amount of requisite variety. Possessing adequate requisite variety allows the system to represent these challenges, decide which environmental elements are relevant to them, and respond appropriately (Ashby, 1956). What is relevant, however, is subject to constant change. For instance, companies that produce micro-processors have always seen developments in miniaturization as highly relevant to their business. Consequently, companies in that industry have created requisite variety that allows them to track developments in the area of miniaturization. By contrast, these companies have hardly observed working conditions in mines for rare earths, even though these minerals are

essential to the manufacture of micro-processors. However, due to recent public outcries about these 'conflict minerals' (Reinecke and Ansari, 2015) and new laws, such as the 2010 Dodd–Frank Act (Lynn, 2011), business firms are now obliged to account for the provenance of certain minerals. To cope with this emerging issue, microprocessor firms have had to increase their requisite variety by setting up management systems to collect relevant information along their entire supply chains and by expanding their reporting systems.

In general, whenever firms identify a new issue as an element of their environment, their overall environmental complexity, and thus their complexity differential, increases as a result of the addition (see arrow A in Figure 1). This increase, however, can threaten their viability. To avert the danger, these firms need to reduce their complexity differential again to a manageable level.

To increase their requisite variety – and thus reduce their complexity differential – firms have to become able to acquire and process information about their environment through appropriate organizational structures and processes. For that purpose, organizations need to develop structures that scan the environment (Aguilar, 1967) in order to collect information externally (Tushman and Nadler, 1978) and augment their informational basis. Since information is often equivocal and can be interpreted in different ways (Daft and Mackintosh, 1981), organizations also need to adapt their structures and processes in order to 'develop information processing mechanisms capable of detecting trends, events, competitors, markets, and technological developments relevant to their survival' (Daft and Weick, 1984, p. 285; Tushman and Nadler, 1978). The creation of such structures and processes increases the complexity of a system and thus enables the system to reduce the complexity differential between itself and its environment. In sum, as the complexity differential between an organization and its environment increases, the organization will need to increase its requisite variety accordingly in response (see arrow B in Figure 1).

Having explained the basic tenets of social systems theory, and why organizations need requisite variety in the first place, we now turn to our main research objectives: to examine how organizations increase their requisite variety by creating either internal or collaborative complexity and to explain why firms combine these two types of complexity in different ways.

ORGANIZATIONAL RESPONSES TO ENVIRONMENTAL COMPLEXITY

Firms can increase their capacity to adapt and react to changes in their environment (i.e., their requisite variety) in two different ways: by creating either internal complexity or collaborative complexity. Figure 2 schematically illustrates the key differences between these two types of complexity. 'Internal complexity' describes structures and processes that are established *within* an organization, and has been amply covered in the literature (Daft and Lengel, 1986; Damanpour, 1996; Galbraith, 1982; Van de Ven, 1976). 'Collaborative complexity', which has been only marginally explored to date, describes structures and processes *between* organizations, which may consist of elements of the participating organizations as well as of elements that lie outside them. Below, we will first discuss internal complexity and then develop the concept of collaborative

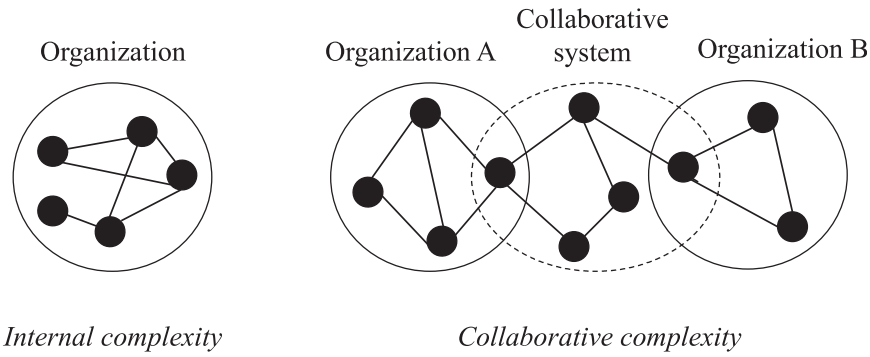

Figure 2. Internal and collaborative complexity

complexity. We will then analyse the factors that explain why organizations combine internal and collaborative complexity in different ways and will go on to explore the field-level feedback effects that result from the responses of organizations to environmental complexity.

Internal Complexity

Social systems can be said to have a high degree of internal complexity if they can represent their environments as highly complex. This capacity increases their ability to process environmental demands and to adapt and react to changes in their environments (Luhmann, 1970). Existing research conceptualizes internal complexity by looking at organizational structures (Blau, 1970; Child and Mansfield, 1972; Hsu et al., 1983) and organizational processes (Daft and Lengel, 1986; Tushman and Nadler, 1978).

Organizational structures can contribute to internal complexity; for instance, through functional specialization. Functional specialization means that individuals and groups focus increasingly on specialized activities (Child and Mansfield, 1972). Through functional specialization, organizations can form representations of more variegated issues in their environments and respond to these issues in a more targeted way. Organizations can also increase their internal complexity through differentiation. 'Horizontal differentiation' refers to the creation of organizational divisions, units, and sub-units (Blau, 1970); for instance, the marketing department of a company may create different units that deal with different consumer groups. Internal complexity increases with the number of such units (Blau, 1970). 'Vertical differentiation' refers to the number of levels of authority: the greater the number of hierarchical levels, the higher the internal complexity of an organization (Hsu et al., 1983). Both types of differentiation increase the ability of organizations to respond to environmental demands (Aldrich and Herker, 1977) and to process information about a complex environment in a more sophisticated manner (Tushman and Nadler, 1978).

Enhancing organizational processes also contributes to internal complexity. Indeed, to be viable over time, organizations continuously strive to balance their structures and processes, because organizations that fail to match highly differentiated structures with similarly differentiated processes may not manage to adapt successfully to substantial

changes in their environments (Schreyögg and Sydow, 2010). For example, to increase their internal complexity, firms could increase the density of communication by consulting a broad range of internal stakeholders, from top-managers to line-employees. This would allow them to take into account a greater range of elements in their environments and to assess better the potential and actual challenges they have to meet. Specific measures that increase the density of communication include introducing (or increasing the frequency of) meetings and intensifying interdepartmental relations (Daft and Lengel, 1986). Such measures enable organizations to initiate a 'discussion until a common grammar and course of action can be agreed on' (Daft and Weick, 1984, p. 291). Improving mechanisms of coordination and control (Tushman and Nadler, 1978), which may involve hiring experts and setting up task forces, also increases internal complexity and enables organizations to handle greater amounts of environmental complexity.

Collaborative Complexity

Organizations can also increase their requisite variety by creating collaborative complexity. 'Collaborative complexity' refers to the collective creation of requisite variety by two or more collaborating organizations. Collaborative complexity is analytically distinct from internal complexity because the former involves the complexity of other organizations with which a specific organization shares a segment of its environment (see Figure 2).

In the case of organizational collaboration, a new social system emerges from different organizations (Luhmann, 1995; Van de Ven, 1976), which we describe as a *collaborative system*. The collaborative system is constituted by the organizations that participate in the collaboration (see Figure 2). Social systems theory suggests that a system can make 'its own complexity [...] available for constructing another system' (Luhmann, 1995, p. 213). This possibility implies that a system – an organization – can draw on the requisite variety of other organizations and 'internalize' their complexity (Luhmann, 1981a). By these means organizations can collectively contribute to the creation of a collaborative system, such as a strategic alliance. Collaborative systems can also create complexity by themselves, in addition to the complexity that participant organizations contribute. For example, industry associations are collaborative systems that provide participant organizations with requisite variety. Building both on the complexity that collaborating organizations produce and on its own complexity, a collaborative system can thus create a certain degree of requisite variety on which the collaborating organizations can then draw to develop responses to specific issues in their respective environments.

For instance, what prompts organizations to collaborate in a strategic alliance or R&D partnership is that they are most likely not capable of accomplishing these activities on their own (Gulati et al., 2012). In such cases, each organization provides some of its internal complexity, such as researchers, hardware, knowledge, while the collaborative system may also create complexity – for example, in the form of an external office for coordinating R&D collaboration. The collaborative system thus creates requisite variety, while the participant organizations can draw on the solutions that the collaborative system generates (for example, in the form of research results).

The joint efforts to create collaborative complexity in order to reduce the complexity differential of the participating organizations can take many different forms and are encountered in a variety of contexts. From the perspective of social systems theory, a salient feature that allows us to distinguish between different types of collaborative systems is the ratio of complexity that the participant organizations contribute to the complexity that the collaborative system creates. On one end of the spectrum of collaborative systems there are interactions such as informal industry roundtables or conferences, where participating organizations contribute some internal complexity, but little complexity is created by the collaborative system itself (see Mohe and Seidl, 2011). On the other end of the spectrum there are collaborative systems such as joint ventures, which draw on the internal complexity of the participant organizations, but also create a high degree of complexity by themselves. Various forms of partial organizations, which selectively utilize elements of formal organizations (Ahrne and Brunsson, 2011), lie between these extremes. Collaborative systems of this type include standard-setting organizations such as the International Organization for Standardization (ISO), strategic alliances such as the Star Alliance in aviation, and industry associations such as the International Air Transport Association (IATA).

The main aim of all these types of collaboration is to develop collective responses and strategies to address environmental complexity. Collaborations among multiple organizations, for instance, often involve setting standards and norms for product quality and lobbying jointly for or against new governmental regulations (King and Lenox, 2000). For example, the International Chamber of Commerce (ICC), an international lobbying organization, 'provides a forum for businesses and other organizations to examine and better comprehend the nature and significance of the major shifts taking place in the world economy' (ICC, 2015). Another important form of organizational collaboration that emerged relatively recently and has been gaining in popularity ever since is the cross-sector partnership (Koschmann et al., 2012; Selsky and Parker, 2005). Cross-sector partnerships illustrate how companies create collaborative complexity in order to address environmental complexity. On the one hand, in cross-sector partnerships, business firms, governments, and civil society organizations join efforts in order to address complex societal problems that they cannot tackle effectively on their own. Such problems may include AIDS/HIV prevention in developing countries where foreign firms run manufacturing operations (Maguire and Hardy, 2005), investments in public infrastructure (Haack et al., 2012), or strategies for the mitigation of climate change (Schüssler et al., 2014). On the other hand, cross-sector partnerships are complex organizations in their own right (Dahan et al., 2010; Seitanidi, 2008; van Tulder et al., in press). Thus, these partnerships illustrate how organizations can tackle complex issues in their environment by creating jointly collaborative complexity.

Certification and auditing associations have also become important potential collaboration partners for business firms (King et al., 2005). Such associations, which often include both business firms and NGOs, 'set standards, accredit other organizations to inspect production sites and check companies' compliance with those standards, and then lend the name of the association, in some way, to companies that are found to be in compliance' (Bartley, 2003, p. 436). One prominent example is the ISO, which sets standards in areas such as quality and management. On the whole, certification organizations provide

requisite variety that enables business firms to acquire and process information more easily and to ultimately reduce their complexity differential. In some cases, the complexity created by the collaborative system might even help reduce the internal complexity of individual organizations. This happens often when organizations replace processes that they had developed internally with processes that they have developed together with other organizations or that have been developed jointly by other organizations in the same system.

To summarize, the starting point of this discussion was a key theoretical mechanism of social systems theory, according to which organizations increase their own complexity in order to respond to increased complexity in their environment and thus reduce their complexity differential. We expanded on this mechanism to show that combining internal and collaborative complexity in various ways allows organizations to reduce their complexity differential. From our discussion so far, we can draw the following proposition (see also arrow P1 in Figure 1):

Proposition 1: An organization that aims to reduce its complexity differential relative to its environment can do so by combining internal and collaborative complexity in different ways.

How Organizations Combine Internal and Collaborative Complexity

In this subsection we discuss two factors that determine how organizations combine internal and collaborative complexity. We derived these two factors from the fundamental distinction that Luhmann (1995, p. 17; emphasis in original) makes 'between the *environment* of a system and *systems in the environment* of this system'. The first factor regards the '*environment* of a system' and reflects an organization's environment in itself. We conceptualize this factor as 'environmental overlap'; that is, the degree to which a specific issue concerns – and is thus part of the environment of – few or many organizations. The second factor reflects the '*systems in the environment* of this system'; more specifically, how other organizations act and how much requisite variety they have already created collectively from an individual organization's point of view. We labelled this factor 'available collaborative complexity'.

Environmental overlap reflects the degree to which the representation of an organization's environment contains the same elements as the representations that other organizations construct of their respective environments. As we argued further up, each organization creates its own representation of its environment by selecting issues that it regards as relevant. When the representations of different organizations' respective environments contain the same elements, there emerge 'various system/environment perspectives, which reciprocally overlap' (Luhmann, 1995, p. 187). When there are several such shared elements, the environmental overlap with regard to a particular issue is high. For example, whereas many firms across industries perceive climate change to be highly relevant to their business (high environmental overlap), only few firms perceive issues such as the labour conditions associated with the mining of conflict minerals as relevant (low environmental overlap). Likewise, while many firms see voluntary standards such as the ISO 9001 quality management standard as potentially relevant to their business, only few firms are likely to see a highly specific technological standard as relevant.

The extent of environmental overlap with regard to a particular issue depends on the number of organizations that regard that issue as relevant: a high degree of overlap means that if environmental complexity increases with regard to that particular issue, several organizations will take notice and be prompted to act simultaneously – and may well do so together. Consequently, high environmental overlap fosters collaboration. This insight, which we derive from social systems theory, reflects the well-documented finding that interorganizational collaboration requires domain consensus (Oliver, 1990; Skelcher and Sullivan, 2008; Van de Ven, 1976). 'Domain consensus' means that organizations agree on the specific goals they want to attain and on the steps they need to take in order to implement their goals (Levine and White, 1961).

In a study on the semiconductor industry, Stuart (1998, p. 671) showed that 'the degree to which the technological focus of a firm is shared by many other organizations' influences the likelihood of alliance formation: the higher the degree to which several organizations share the same technological focus, the greater the likelihood that they will join forces to tackle issues that relate to their shared concerns. As a corollary to these observations, we posit that when several organizations perceive an increase in environmental complexity with regard to a specific issue, they are likely to create collaborative complexity in response. This can be summarized as follows (see also arrow P2a in Figure 1):

Proposition 2a: The greater the number of organizations that regard an issue as a relevant element of their respective environment, the higher the ratio of collaborative to internal complexity within each organization.

Available collaborative complexity is the second factor that determines whether organizations increase their internal or collaborative complexity in response to an increase in the complexity of their environment. Available collaborative complexity reflects the degree to which other organizations have already developed a collective response to the same issue. To illustrate this, in Figure 1, arrow A* mirrors arrow A. This indicates that novel issues do not affect just the focal organization but can also increase the complexity differential for other organizations. If other organizations have developed collective responses, an organization confronted with an increase in complexity that results from that same issue can amplify its requisite variety by joining existing collaborations. In short, a high degree of available collaborative complexity means that there are opportunities for creating collaborative complexity by working together with other organizations that have already dealt collectively with the same issue. This indicates that an existing network of interacting organizations stimulates its own growth (Luhmann, 1981b, p. 361), because it attracts new members. This echoes the findings of Powell et al. (1996, p. 143) in the field of biotechnology, who found that 'the field is becoming more tightly connected not in spite of, but because of a marked increase in the number of partners involved in alliances'. In other words, the existence of interorganizational collaborations in a field fosters the occurrence of new collaborations: available collaborative complexity generates more collaborative complexity.

To recap, if there are no collective responses from other organizations to a specific issue that an organization faces (i.e., the available collaborative complexity is low), this

organization will be inclined to create internal complexity. If there are already responses that the focal organization could benefit from (such as an alliance between other organizations that face the same challenge), creating collaborative complexity becomes a more likely option, because it is a more effective way of creating requisite variety and enduringly expanding its competencies (Powell et al., 1996). We summarize this in the following proposition (see also arrow P2b in Figure 1):

Proposition 2b: The higher the collaborative complexity that other organizations have already created with regard to a specific issue, the higher the ratio of collaborative to internal complexity within an individual organization to which that issue becomes relevant.

Feedback Effects on Environmental Complexity

We now turn our attention to the implications that the creation of collaborative complexity by an organization has for the complexity differential that other organizations in the same field perceive. These organizations include competitors, suppliers, governmental agencies, NGOs, and auditing firms. An organization has only a limited capacity to observe the internal complexity of other organizations in its environment (e.g., by means of benchmarking); however, it can observe more easily the complexity that emerges through collaborations between other organizations. Information on existing collaborations might either spread through third parties (Burt and Knez, 1995) or through previous direct ties (Podolny, 1994). From the perspective of social systems theory, when an organization that is part of the environments of other organizations increases its collaborative complexity, the feedback effects of this action increase the environmental complexity that these other organizations perceive and thus their complexity differential.

When firms form strategic alliances, join industry associations, partner with certification bodies, or engage in cross-sector partnerships, they do not merely create collaborative complexity for their own use, but also contribute to the emergence or consolidation of such initiatives. In the aviation industry, for instance, few major airlines can afford *not* to join one of the leading global strategic alliances (Fan et al., 2001). Similarly, in the case of broader industry collaborations, major software and hardware producers decided to cooperate within the USB (Universal Serial Bus) and the FireWire consortiums in order to develop uniform data transfer standards (van den Ende et al., 2012). In the case of these two industries, as more and more firms joined the respective collaborative initiatives, participation grew from a marginal phenomenon to an essential requirement for most firms within the respective industry.

Previous research has shown that collaborations between companies and NGOs often lead to new products and strategies (Kourula and Halme, 2008) and thus increase competitive pressure on rivals. Similarly, companies that adopt standards such as ISO 9001 (quality management) or ISO 14001 (environmental management) create pressure that forces their competitors to pay attention to elements in their environments that they previously perceived as much less relevant (King et al., 2005). Obviously, not all organizations will conform and adopt any novel standard or initiative. However, it is reasonable

to assume that most firms will dedicate at least some resources to evaluating whether or not a certain initiative or standard is relevant to their own business.

Our model examines the dynamics behind these processes and helps explain how the activities of organizations feed back into the context that influences these and other organizations (Meyer et al., 2005). It shows that a firm's response to an increase in its complexity differential affects other organizations in the environment of this firm and that when a firm creates collaborative complexity in order to respond to a particular issue, this action induces responses from other firms. We summarize this effect in the following proposition (see also arrow P3 in Figure 1):

Proposition 3: If other organizations can observe an increase in the collaborative complexity of an individual organization, this will lead to an increase in the environmental complexity that these organizations perceive.

As Figure 1 shows, an increase in the complexity differential of other organizations will induce them to increase their requisite variety. In that figure, arrow B* mirrors arrow B, which indicates that other organizations respond to increases in their complexity differential in the same way as the focal organization: both increase their requisite variety. As we have seen, organizations can increase their requisite variety by creating either internal or collaborative complexity. When the other organizations create collaborative complexity, the resulting increase in available collaborative complexity will make it more likely that the focal organization creates collaborative rather than internal complexity (see arrow P2b). We thus see a positive feedback loop between the collaborative complexity that different organizations create.

In summary, our model suggests that organizations combine internal and collaborative complexity in different ways in order to reduce their complexity differential. We posited that an organization is more likely to create collaborative complexity if an issue that this organization regards as relevant is also perceived as relevant by other organizations (high environmental overlap) and if other organizations have already developed responses to that issue (high available collaborative complexity). We also argued that an increase in an organization's collaborative complexity will induce an increase in the environmental complexity that other organizations perceive. In the next section, we will apply our model to the context of corporate social responsibility (CSR).

APPLYING THE MODEL IN THE CONTEXT OF CSR

We define CSR as an umbrella term that describes the complex and multifaceted relationships between businesses and society in terms of the environmental, ethical, and social impact that their activities have (Baumann-Pauly et al., 2013). The example of CSR is particularly suitable for illustrating our model for two reasons. First, CSR-related issues represent a considerable increase in environmental complexity that nearly every business firm has to deal with nowadays (Campbell, 2007). Such issues include human rights, labour norms, climate change, anti-corruption management, poverty, inequality, and tax evasion (Levy et al., 2015; Reinecke and Ansari, 2015; Scherer and Palazzo, 2011). Bromley and Meyer, for instance, argued that nowadays multinational

corporations are 'transformed by new pressures to look like responsible actors' and that laws and public pressure force them to 'take on expanded concerns such as environmental protection, corporate social responsibility and philanthropy, employee rights and job satisfaction, workplace diversity, community engagement, and consumer safety' (Bromley and Meyer, 2014, p. 7). In short, CSR represents a set of issues that potentially increase the complexity of a firm's environment.

Second, firms to which CSR is relevant often create both internal and collaborative complexity (Hart, 1995; Rasche et al., 2013; Wickert, 2014). With regard to internal complexity, firms often create organizational structures that enable them to process systematically CSR-related issues. For example, they may establish a CSR department, introduce operating procedures such as codes of conduct or human rights policies, train employees to handle such issues effectively, or create mechanisms that promote compliance and reporting (Baumann-Pauly et al., 2013).

Increasingly, however, many firms tackle CSR issues also by creating collaborative complexity: this involves introducing or adopting various forms of collaborative industry self-regulation with regard to various social and environmental issues (e.g., King and Lenox, 2000; Mena and Waeger, 2014), working together with NGOs in cross-sector partnerships, joining multi-stakeholder initiatives (Rasche, 2012) such as the Global Reporting Initiative (GRI), or participating in industry round tables to address issues such as the mining of conflict minerals or child labour in textile supply chains (Baumann-Pauly et al., 2013; Reinecke and Ansari, 2015). Joining such initiatives and sharing solutions can also be important from a strategic point of view because collaborative efforts may allow firms to reduce information asymmetry (see Siegel and Vitaliano, 2007) between themselves and other market participants that are confronted with similar CSR-related challenges.

In what follows we use our model to explain why firms create different combinations of internal and collaborative complexity in the context of CSR. Figure 3 shows four ideal-type situations in which the ratio between internal and collaborative complexity varies, depending on the combination of environmental overlap and available collaborative complexity.

Quadrant 1 of Figure 3 represents cases of low available collaborative complexity and low environmental overlap: few firms, if any, have already responded to a specific issue and few recognize the same specific issue as relevant. This type of situation can be illustrated by the case of Google, which was accused of violating the right of freedom of speech in China (see, e.g., Brenkert, 2009; Dann and Haddow, 2008; Morris, 2014). Google China, a subsidiary of Google Inc., was heavily criticized for announcing in 2006 that it would comply with China's laws on Internet censorship, setting up a 'website block-list based on terms that Google found were being filtered by Chinese Internet providers' (Morris, 2014, p. 194). In 2009, however, the Chinese authorities blocked access to YouTube, which is part of Google, on account of footage that the authorities considered offensive. A year later, Google, together with other US technology companies, was targeted by China-based hackers. In response, Google announced that it would no longer comply with the Chinese authorities' rules of censorship. The clash over censorship between a corporation of that magnitude and a national government was highly idiosyncratic (which meant that the environmental overlap was low). Few

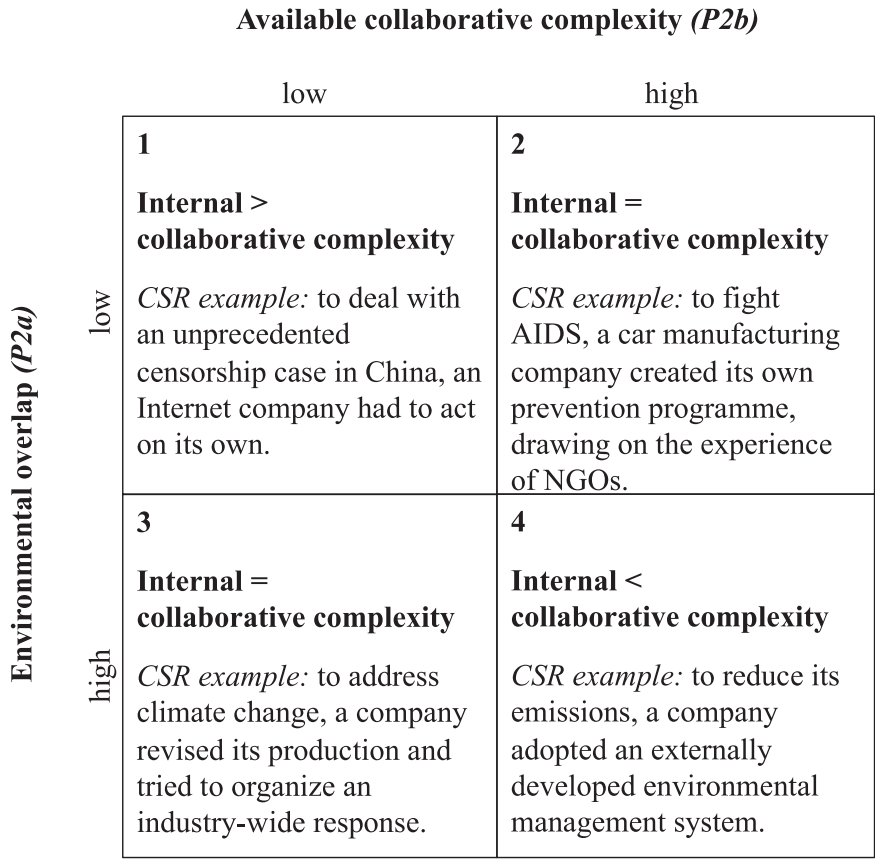

Figure 3. Two factors that determine how organizations combine internal and collaborative complexity

competitors had faced similar issues in the past in comparable contexts (Microsoft and Yahoo! are notable exceptions; see Dann and Haddow, 2008), making this case unprecedented. As a result, Google had few potential partners with whom to address this problem collectively (so the available collaborative complexity was low).

Google created some degree of collaborative complexity by joining the Global Network Initiative (GNI), to seek partners with whom it could jointly address issues of Internet privacy. However, Google also faced a much more pressing need to readjust continuously its internal processes and policies. This included defending its servers constantly against sophisticated cyberattacks (Jacobs and Helft, 2010) and eventually relocating its services from mainland China to Hong Kong in 2010 (Kim and Douai, 2012). In other words, due to low environmental overlap and low available collaborative complexity, tackling the problem required the company to create a much greater amount of internal complexity than of collaborative complexity.

Another illustrative case in which internal complexity exceeded collaborative complexity is that of producers of organic food in the early stages of the industry (Latacz-Lohmann and Foster, 1997). In that phase, the number of firms that regarded various issues associated with organic food as relevant to their business was low, so the

environmental overlap was correspondingly low. Furthermore, at the time there were few appropriate industry standards and initiatives, which meant that the available collaborative complexity was also low. For those reasons, these firms had to develop adequate practices primarily on their own, which required a relatively high degree of internal complexity, while the degree of collaborative complexity remained relatively low. Both examples show that organizations that need to tackle a specific issue when both environmental overlap and available collaborative complexity are low have to rely primarily on internal complexity to create requisite variety. In such cases, internal complexity is higher than collaborative complexity.

Quadrant 2 in Figure 3 represents cases of low environmental overlap and high available collaborative complexity. In such cases, although few organizations recognize the same specific issue as relevant, other organizations have already addressed this issue and thus created requisite variety. Many cross-sector partnerships illustrate this situation. Typically, such partnerships emerge when a multinational corporation wants to invest in a developing country where public infrastructure in the immediate surroundings of the investment site is inadequate or non-existent (Valente and Crane, 2010). Cross-sector partnerships require that firms jointly create a high degree of collaborative complexity; in other words, all actors involved need to develop their responses to specific challenges jointly and to harness the expertise of NGOs and governments for that purpose. At the same time, such collaborations demand that organizations create a considerable degree of internal complexity, because the participants need to adapt their internal organizational structures and processes (Rondinelli and London, 2003).

For instance, in the last decade, several automobile manufacturers such as Daimler or BMW partnered with NGOs and governmental agencies in South Africa to mitigate the problem of AIDS/HIV among their workforces. To that end, they developed jointly internal prevention programmes targeted at their employees, which involved measures such as medical check-ups and the provision of assistance to those affected (Krasner and Risse, 2014). A similar example is the close cooperation between Starbucks and NGOs in order to foster environmental and labour standards in the coffee supply chain, which involved getting businesses in developing countries with a poor track record in these areas to adopt such standards. In the course of this cooperation, Starbucks created diverse multi-tiered teams (Arya, 2006) and worked on the development of internal corporate processes (Rondinelli and London, 2003). In sum, the examples in Quadrant 2, Figure 3, represent a balanced ratio between internal and collaborative complexity.

Quadrant 3 in Figure 3 represents cases of high environmental overlap but low available collaborative complexity with regard to a specific issue. In other words, although several organizations recognize the same issue as relevant, few have produced collaborative responses to that issue. This case is exemplified by so-called 'collective action problems'; that is, generally recognised societal problems for which there is no widely accepted solution (Ostrom, 1990).

A prominent issue in this quadrant is climate change (Klein, 2014; Rockström et al., 2009; Stern, 2006). At the level of individual business firms, there is increasing awareness of climate change and many firms attempt to address this problem through internal policies and practices of sustainability (Wittneben et al., 2012). At the same time, the fact that environmental problems related to climate change affect the business strategies of many

corporations means that it makes sense for organizations to share resources and address such problems collectively. However, as Pinkse and Kolk (2012) have recently argued, collaborative approaches to addressing climate change are largely still in their infancy. Given that the amount of available collaborative complexity is limited, companies that intend to address climate change must create not only collaborative complexity, but also internal complexity to build up the necessary requisite variety. In sum, Quadrant 3 represents cases with a balanced ratio between internal and collaborative complexity.

Quadrant 4 in Figure 3 represents cases of high environmental overlap and high available collaborative complexity: many organizations regard the same issue as relevant and some of these have started to tackle it collectively. In such situations, an organization that is confronted with a particular issue and seeks to reduce its complexity differential can benefit from the effort of other organizations that have already produced a response to that issue. Accordingly, in such cases the degree of collaborative complexity exceeds the degree of internal complexity.

Voluntary initiatives in the context of CSR illustrate such cases; such initiatives range from cross-industry standards, such as the ISO 14001 standard of environmental management, to sector-specific initiatives, such as the Extractive Industry Transparency Initiative (EITI). In all these cases, the effort that organizations are required to make in order to develop a specific solution to a specific problem is shared by many actors, including competitors, governments, and NGOs.

For instance, when an organization adopts an environmental management scheme, such as ISO 14001 or EMAS, it benefits from the fact that other organizations – the ISO in the case of ISO 14001 and the European Commission in the case of EMAS – have already developed such a scheme, which required of them a high degree of requisite variety. Drawing on these efforts makes it relatively easier for an organization that adopts such a scheme to reconfigure its internal processes. Similarly, maintaining 'arm's length' relations with NGOs (Rondinelli and London, 2003) and contributing to charitable causes that are related to a particular problem but only loosely connected to a firm's core business (Husted, 2003), create little, if any, internal complexity because most of the effort required in order to solve that problem burdens other organizations. In sum, the examples in Quadrant 4 of Figure 3 reflect a high ratio of collaborative complexity to internal complexity.

Having illustrated the capacity of our model to explain why organizations create variegated responses to environmental complexity, we will now discuss how it contributes to existing theory, explore considerations for empirical research, and sketch directions for future research [Correction added on 29 April 2016, after first online publication: This sentence has been corrected.].

DISCUSSION

Contributions to Theory

In this paper, we developed a systems theory perspective to explain why organizations respond to the complexity of their environments either individually or collectively. The first contribution of our paper is that it adds to the significant body of research on organizational responses to environmental complexity (Burns and Stalker, 1966; Galbraith,

1982; Ghoshal and Nohria, 1989; Lawrence and Lorsch, 1967; Siggelkow and Rivkin, 2005) as well as to the literature on interorganizational collaboration (Dyer and Singh, 1998; Hardy et al., 2003; Powell et al., 1996). Early research on the relationship between organizations and their environments (Burns and Stalker, 1966; Lawrence and Lorsch, 1967) has shown that organizational structures and processes need to be adapted to environmental conditions if organizations are to survive. The idea that in order to remain viable in the presence of increased environmental complexity organizations need to become more complex has now become textbook knowledge. Here, we expand this line of inquiry in an important direction.

In many cases, organizations address challenges in their environments collectively rather than on their own (Huxham and Vangen, 2005). Although this topic has been explored to some extent, most previous studies do not conceptualize or analyse adequately interorganizational collaboration in the form of collective responses to environmental complexity. Aware of this shortcoming and responding to the call of La Cour et al. (2007, p. 932) on researchers to demonstrate 'the potential and promise of a systems theoretical approach to organizational studies', we developed the concept of collaborative complexity. Building on social systems theory, we conceptualized interorganizational collaborations as distinct social systems. This enabled us to offer a mid-range theory that regards the collaboration of a business firm with other organizations (such as competitors, NGOs, auditing organizations, suppliers, and industry associations) as a way of reducing the complexity differential between that firm and its environment.

Our concept of collaborative complexity helps explain organizational collaboration in a variety of contexts. The different forms of organizational collaboration that can be conceptualized as manifestations of collaborative complexity range from direct interactions between two organizations (Mohe and Seidl, 2011), to organizational networks (Gulati et al., 2000; Provan et al., 2007), and to different forms of partial organizations (Ahrne and Brunsson, 2008, 2011).

Second, our paper contributes to the literature on interorganizational collaboration. The model we developed sheds light on two factors that determine why organizations create internal or collaborative complexity: environmental overlap and available collaborative complexity. To explain the mechanisms that are associated with either internal or collaborative complexity, we drew on social systems theory. Our approach complements resource-based explanations of interorganizational collaboration (Ahuja, 2000) and previous attempts to examine the contextual determinants of interorganizational collaboration (see, e.g., Sorenson and Stuart, 2008).

In this paper, we applied our model in the CSR context; nevertheless, it is important to note that our model can be used to examine collaborative organizational responses to environmental complexity in other contexts. For instance, in situations that call for co-opetition[1] (Hamel et al., 1989) organizations have the opportunity to interact in order to lower the risk that environmental complexity poses. Co-opetition refers to 'a strategy embodying simultaneous cooperation and competition between firms' (Gnyawali and Park, 2011, p. 650), and may involve relationships with multiple vertical and horizontal stakeholder groups such as competitors, buyers, suppliers, or even intraorganizational business units (Tsai, 2002). In our view, co-opetition is a form of cooperation between firms that allows them to create collaborative complexity. Consequently, the two factors

that we identified, i.e., environmental overlap and available collaborative complexity, can also help explain under which conditions co-opetition is likely to emerge and which form it might take.

When applying our model scholars need to be sensitive to the degree of competition associated with a certain issue. Competition implies diverging objectives between firms because each firm tries to stay ahead of other firms; environmental overlap will thus be lower the higher the competitive pressures. For instance, when comparing CSR and co-opetition we have to take into account that co-opetition involves higher degrees of competition than CSR. By contrast, in CSR settings, firms will try to collectively resolve an issue rather than stay ahead of other firms; environmental overlap can thus be high. Environmental overlap, in turn, will influence whether firms primarily create internal or collaborative complexity.

The third contribution of our paper is that it broadens the scope of social systems theory. Whereas extant research in this theoretical tradition mainly focuses on either intraorganizational (see, e.g., Schoeneborn, 2011) or interorganizational dynamics (see, e.g., Mohe and Seidl, 2011), we connect these two levels and thus illuminate the endogenous dynamics of change of network structures on the field-level (Meyer et al., 2005; Strang and Sine, 2002). Specifically, we conceptualize the network structure of an organizational field (Kenis and Knoke, 2002) as the extent of collaborative complexity in that field. We thus see organizational fields as temporarily stable patterns of organizational relationships that may change under certain conditions. We suggest that the pattern of internal and collaborative complexity may change from one stable state to another when the change of contextual conditions exceeds a certain threshold.

For instance, in cases where there is a low degree of available collaborative complexity, rising awareness of the relevance of an issue – which represents an increase in environmental overlap – might trigger the creation of collaborative complexity. If the level of available collaborative complexity does increase subsequently and exceeds a certain threshold, there might be a shift from mainly individual responses to a particular issue towards mainly collective responses. In such cases, the network structure of a field switches from one stable state, in which internal complexity exceeds collaborative complexity from the viewpoint of individual organizations in that field, to another state, where collaborative complexity exceeds the level of internal complexity, thus transforming the structure of the field.

We posited that the different types of complexity an individual organization can create with regard to a particular issue, the reactions of other organizations to that issue, and their effect on the different forms of complexity that the focal organization creates are all interconnected. One might assume that the adaptations of all organizations that are interconnected by a particular issue will constantly and perpetually generate new patterns of internal and collaborative complexity. However, the patterns that can be observed in practice are relatively stable (Kim et al., 2006). In the context of our model, stable patterns of internal and collaborative complexity can be regarded as 'eigenvalues' (von Foerster, 1984), 'attractors' (Holland, 2000; Kauffman, 1993), or stable states, which are characteristic of many complex systems (Anderson, 1999; Dooley and Van de Ven, 1999; Levy and Lichtenstein, 2012). Building on this perspective, our model

responds to the call on researchers to analyse organizational collaboration by focusing on 'the types of attractors that emerge in relationships under various network and environmental conditions and on the kinds of equilibrating processes occurring that lead to the emergence of different attractors' (Wilkinson and Young, 2002, p. 130).

Considerations for Empirical Research

Complexity is a highly abstract concept that social systems theorists (e.g., Luhmann, 1995) and organization theorists (e.g., Daft, 1992; Scott, 1992) have defined in many different ways. Operationalizing the key concepts of our model – internal and collaborative complexity – will thus be challenging for future empirical research (on challenges related to the operationalization of 'requisite variety' see de Raadt, 1987).

Traditionally, organization theorists have operationalized internal complexity in different ways. Some focused on functional specialization, which refers to 'the extent to which there are specialist roles for given functional activities' (Hickson et al., 1969, p. 386). Others operationalized it in terms of vertical and horizontal differentiation (Blau and McKinley, 1979; Damanpour, 1996; Larsen et al., 2013), which are measured by the number of different functions and hierarchical layers within an organization (Pugh et al., 1968). Yet others focused on the density of communication (Daft and Lengel, 1986), which is commonly measured through surveys on how frequently the members of an organization communicate (Jia et al., 2014).

However, the ways in which companies build internal complexity nowadays differ from those that theorists who examined large corporations described in the 1960s and 1970s (Blau, 1970; Child, 1973). While traditional corporations were highly centralized, relatively stable, asset-intensive, and vertically integrated, many contemporary corporations are highly decentralized, extensively relying on human capital, and in constant flux (Zingales, 2000). As Davis (2009, p. 41) quipped, traditional organization theory is largely the 'science of General Motors'. This, however, raises doubts as to whether the 'traditional' definitions and measures of complexity are still appropriate or indeed useful.

In response to this question, future empirical research could re-examine the structures and processes through which organizations build internal complexity. For example, to ascertain whether organizations with high internal complexity form more nuanced representations of their respective environment, researchers could ask managers how they see their organization's environment and the challenges it poses. Researchers can use various concepts to make sense of managers' responses: from mental models (Porac and Thomas, 1990) to cognitive categories (Barr, 1998; Kaplan, 2008) and attention (Ocasio, 2011). Methods such as qualitative comparative analysis (Fiss, 2007) could then help identify configurations of structures and processes with which innovative organizations can represent their environments in a highly complex way.

Measuring collaborative complexity is equally challenging because there is little research on that concept. One way to measure collaborative complexity involves measuring the number of participants in interorganizational relationships (e.g., self-regulation initiatives in an industry) and the number of tasks and projects (e.g., joint

ventures, industry round-tables, or cross-sector partnerships) that are undertaken in the context of such relationships (Van de Ven, 1976).

Several measures can serve as a proxy for the degree of communication density between organizations. These measures include the extent of information exchange between organizations (for example, through e-mail; see Allatta and Singh, 2011), the number of meetings between the members of collaborating organizations, and the position of an organization in the field's communication network (Knoke, 2004). Taken together, these measures may serve as proxies for collaborative complexity, which could be further assessed by means of network analysis (Scott, 2000). In addition, scholars can build upon more outcome-oriented measures for collaborative complexity, such as the extent to which a certain standard is adopted by major industry players (see, e.g., Haack et al., 2012), or what proportion of the market is controlled by various strategic alliances in an industry.

Directions for Future Research

Our model provides several opportunities for further research. First, future studies could refine the conditions under which organizations achieve their objectives more effectively by responding to environmental complexity individually or jointly. The findings of such studies would add to the literature on network formation (Brass et al., 2004; Sorenson and Stuart, 2008) and interorganizational cooperation (Gulati et al., 2012) and help specify the factors that determine the nature of collaboration and the composition of collaborative systems.

Second, studies that test our ideas empirically could prove relevant to research on the implementation costs of strategic decision-making (Larsen et al., 2013) by highlighting the differences between functionally equivalent alternatives for addressing problems in the environment of business firms. Estimating the cost of creating internal or collaborative complexity could help assess how efficient internal complexity and collaborative complexity are. In the case of firms that have not implemented yet a certain standard or do not belong to a strategic alliance (McWilliams et al., 2002) it could also help explain how different configurations of complexity affect the competitive advantage both of the firm that applies them as well as that of its rivals. The findings of such investigations could help explain how internal and collaborative complexity affects performance and which combinations yield the highest payoffs in the long-term.

Third, building on our approach, future research could take a dynamic perspective on different forms of complexity that organizations create, as well as on the links and interplay between internal and collaborative complexity. As Luhmann (1995) observed, to draw on the requisite variety of other systems requires that a system creates a certain degree of internal complexity. In other words, creating collaborative complexity requires that organizations create also some internal complexity. To examine this prerequisite in depth, researchers could analyse longitudinal data on the formation of interorganizational collaborations and networks in order to examine how they co-evolve. In the context of CSR, for example, scholars could study how internal complexity develops over time relative to collaborative complexity, by measuring, for example, the number of CSR managers in an organization and the amount of externally available

guidelines and best practices provided by initiatives such as the UN Global Compact. Finally, researchers could also test the conjecture that as collaborative complexity becomes more readily available, the need for CSR managers as carriers of CSR-related knowledge inside organizations will decrease (Strand, 2014).

CONCLUSION

In this paper, we used social systems theory to develop a model that explains the reactions of organizations to environmental complexity on the basis of two central concepts: environmental overlap and available collaborative complexity. We explained why organizations respond to environmental complexity by creating internal complexity through the modification of their structures and processes, or by creating collaborative complexity through collaboration with other organizations, or by combining these two options in various ways. Thereby, we demonstrated that social systems theory, which remains relatively neglected in organizational research despite its long tradition in the German-speaking scholarly community, can provide a fresh perspective on how organizations deal with complexity in a world that many see as increasingly complex.

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NOTES

[1] We thank an anonymous reviewer for bringing this example to our attention.

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